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ABSTRACT

Compared were gender differences among Asian and Caucasian high school students enrolled in advanced science and mathematics research classes. Two explanations for the large gender differences among scientists, mathematicians, and engineers are discussed: (1) females elect fewer advanced science and mathematics courses in high school and college, and are thus prevented from entering technical-scientific fields; and (2) large sex differences exist in specific innate abilities. It is held that should the latter be true, then these gender differences would appear among all ethnic groupings. If, however, these differences disappear, then the achievement differences might be related to different socialization patterns. Using this premise, the study involved 27 high schools with atypical numbers of Asians and/or females enrolled in advanced science and mathematics courses. A questionnaire was given to 209 Caucasian and 78 Asian students, followed by interviews with 39 students. Asian students devoted much more time to studying and research activities, with their families very supportive of such dedication, for both sexes. Asian students tended to retain the attitudes and values of their former countries, were more influenced by peers and others to achieve, and were more competitive than Caucasian students. Asian females read more technical books and knew more computer languages, while Caucasian females emphasized socialization. Both sets of females tended to have lower positive attitudes toward themselves. The Asian males as a group had very few negative stereotypes of the gifted girls in their classes, while American males had many negative perceptions of gifted females in their classes. Implications of the differences are commented upon. (MNS)

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IMPACT OF ETHNICITY ON MATH AND SCIENCE AMONG THE GIFTED

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Introduction

In every survey of scientific-technical manpower, males outnumber females (NSF 1974, 1975, 1980). The key question is why are there so few female scientists, engineers and mathematicians? The gender gap seems to first appear during the high school years when students can elect different advanced courses in science and mathematics. In many schools very few females select these advanced courses. By the time the students reach the 12th grade, large gender differences appear in math and science achievement. The most noticeable sex difference occurs with the Scholastic Aptitude Test (SAT-M) (College Entrance Examination Board, 1982). An even larger sex difference occurs among the winners of contests like the Westinghouse Talent Search (Connolly & Primavera, 1983). We have found that these sex differences disappear for some variables when Asian high school students are compared. The objective of this study was to compare the gender differences among Asian and Caucasian high school students who were enrolled in advanced science and math research classes. Are the Asian females more like Caucasian males than Caucasian females? Do the Asian females have important differences in motivation, socialization and attitudes? Do the Asian students, as a group, differ from their Caucasian classmates?

Background

Although only 1.7% of the total population of the New York region consists of Asians, they make up more than 20% of the students in many of the gifted programs (Time, 1983). Similarly, Asian stu-

dents enroll in large numbers in advanced science and math courses and consequently excel in contests like the Westinghouse Talent Search. In a study of the New York region's Westinghouse winners from 1975 to 1983, Connolly & Primavera (1983) found that Asians accounted for 17.5% of the region's winners. They also found that among Caucasians, only 27% of the winners were females, but among the Asians, 46.5% were females. This finding was a prime reason for conducting the study described in this article.

Theoretical Framework

Several different explanations have been proposed to explain the large gender differences among scientists, mathematicians, and engineers. Two different explanations have been proposed. One explanation that has been advanced is that the differences are due to females electing fewer advanced math courses at the high school level. Since fewer females continue to pursue math courses during high school, they score lower on the Scholastic Aptitude Test. This liability follows the females to college where they again elect fewer math courses. When it comes time to select a college major, many of these young women are prevented from entering the technical-scientific fields because of these math deficiencies. This explanation has been called "the differential coursework hypothesis" (Tobias, 1980). It has been supported by Fennema (1980), Fox & Cohn (1980), Casserly (1980) and Pallas & Alexander (1983). The reasons given for females electing fewer high school math courses include different socialization patterns than males, and a general lack of interest in the subject.

The counter hypothesis is that the large sex differences in specific innate abilities are responsible for the disproportionate number of males in the technical areas. The two abilities that are cited most frequently are spatial relations and mathematical reasoning. This hypothesis has been advanced by Page (1976), and Benbow & Stanley (1980, 1982, 1983) (see Note 1). The basic idea behind this hypothesis is that socialization can't explain away the large gender differences among highly talented precocious math students at the 7th and 8th grade levels. During the elementary school years gender differences are reported to be minimal when the topics are largely computational, but when math reasoning is required, then the large sex differences begin to appear. It should be noted that several test developers publish separate norms for males and females in a number of different areas. In future years researchers could very well uncover additional areas where large sex differences occur.

Both explanations agree on a number of different facts:

1. More males take advanced math and science courses in high school.
2. Males score higher on the SAT-M.
3. More males win Westinghouse awards.
4. More males take engineering, physical science, and mathematical courses in college.
5. More males select science and math majors in college.
6. There are more male scientists, engineers and mathematicians.

Our study involved 27 high schools that had atypical numbers of Asians and/or female students enrolled in their advanced science and

math courses. We placed the students into four groups:

1. Caucasian males
2. Asian males
3. Caucasian females
4. Asian females

We used this sample of students to study the controversy from a different viewpoint. If the differences in math achievement are largely due to innate abilities, then these differences should appear among all ethnic groupings. But if the differences disappear among any one ethnic group, then the achievement differences might be related to different socialization patterns in that culture.

Methods

Both quantitative and qualitative data were used in this study. The quantitative data were supplied by a questionnaire. This instrument was developed by combining items from two of the questionnaires currently being used by the Study of Mathematically Precocious Youth (SMPY). Additional items were included to provide information about sexual stereotyping. The 13-page questionnaire collected data in the following areas: demographic (personal and family), attitudes/values, motivation, gender stereotypes, and school information. These data were used in several different discriminant analyses. The qualitative data used in this study were collected by interviewing 39 of the students who completed the questionnaire. The interviews lasted from one to three hours and examined the students' motivation, their expectations, their family support systems, and their sexual stereotypes.

Data Source

This study used data from 209 Caucasian students (99 males, 110 females) and 78 Asian students (36 males, 42 females) enrolled in advanced science and math courses from 27 different public and private secondary schools in New York City. All subjects completed the questionnaires, and 21 Caucasians (11 males, 10 females) and 18 Asians (9 males, 9 females) were interviewed. The data from both sources were used in all analyses.

Results

We have analyzed the results under two different headings: (1) Ethnicity - A comparison of the Asian and Caucasian students in general. (2) Interaction of Ethnicity and Gender - A Comparison of Caucasian males, Asian males, Caucasian females, Asian females.

Ethnicity - Comparison of Asians and Caucasians

One of the clearest conclusions that can be made from this study involves the amount of time the Asian students devoted to studying and to related research activities. The Asians simply worked much harder than their Caucasian classmates. In fact, they reported studying more than twice as much as the American students. Since all of the students in the sample were active in doing research, it was also possible to tabulate the amount of time devoted to such projects. Again, the Asians of both sexes devoted much more time. Some of them reported studying until 1 or 2 a.m. most days of the week. In all cases their families were very supportive of such dedication. This level of commitment could well account for the high level of

success that the Asians had in the national contests.

We also found that 77% of the Asians studied were born overseas and tended to retain many of the attitudes and values of their former countries. In general, the Asian students were much more group-oriented than the Americans. These Asian students were more influenced by their peers to enroll in the advanced courses. They were also more influenced by their parents and their extended families than their American counterparts. For example, Asian parents took a much more direct and systematic approach to the education of their children. In the early years, homework was closely supervised. In some cases the father took direct responsibility for tutoring; in other cases the mother checked all the daily homework assignments. By the time the students reached high school, the family had instilled very high expectations that were taken much more seriously than the expectations transmitted by the American parents. It should be emphasized that this group of students were, for the most part, recent immigrants to the United States. As a group they seemed to view their educational opportunities as a 'once-in-a-lifetime' proposition. By contrast, the American students seemed to be trained to take charge of their own education. A sense of independence seemed to be emphasized by their parents.

The submersion of the self for the good of the group also emerged when we analyzed the Asians. The Asians were quite willing to settle into a job where the satisfaction would be low if the job resulted in greater benefits for the family. They were also expecting to carry on the responsibility of financial support of their parents as they aged. The Americans were just the opposite in both areas. The Asians also

were less concerned with their own personal freedom than their American counterparts.

The Asians as a group were much more competitive. Both Asian males and females exhibited a good deal of commitment to win awards and scholarships in contests such as the Westinghouse Talent Search. The words "honor" and "prestige" seemed to mean something very special to them and seemed to be more of a source of motivation than to their American classmates. The Caucasian students were much more ambivalent about such contests and also about competition in general. Summarizing this segment of the data, we found that the supportive networking of the Asian family seemed to be responsible for much of the inner drive that these students exhibited.

Interaction of Ethnicity and Gender - A Comparison of Caucasian Males, Asian Males, Caucasian Females and Asian Females

The Asian females read more technical books and they knew more computer languages than any other group. In contrast, the American females reported reading more fiction than any other group. They also knew the least computer languages. These two variables taken together add up to a technical literacy which has great potential for further achievement in college and also has implications for future careers. The fact that the American females lagged behind in such an important area could help explain why many of them had such little success in their research projects. While the Asian females were busy gaining technical literacy, the American females were spending much more of their time in socializing activities. The American females also placed much greater importance on socializing than any other group.

Both groups of males saw sports as more important in their lives than the females. It is interesting to note that the Asian females rated sports much higher than the American females. In general, we found that the Asian females' level of competitiveness approached that of the males in several ways. In terms of participating in sports, both male groups spent more time than the females. The Asian females spent the least time in outdoor activities, while the other three groups spent comparable amounts of time in this activity.

Both sets of females tended to have lower positive attitudes toward themselves. One of the most revealing findings that differentiated the females came from the semantic differential item that asked the subjects to rate themselves on a scale that had "conservative, stick to established methods" on one pole and "radical, willing to experiment" at the other pole. The Asian females rated themselves toward the radical pole. In fact, they considered themselves significantly more radical than any of the other groups.

Both groups of females rated their research activities as more important than both groups of males. This finding seemed to contradict the actual research output of these students, particularly for the American females. Despite their high rating of their research activities, they did not put in as much time as the other groups and did not do nearly as well in the different competitions.

Since this entire sample of students was involved in the different research competitions, we asked them how they would handle any resentment that accompanied success in this area. Most of the students in

all four groups felt that the success would outweigh the resentment. For this reason they would not be upset. However, a good number of Caucasian males reported being angry about the resentment. A smaller number of Asian males and Caucasian females also reported anger when the problem emerged.

The Asian males as a group had very few negative stereotypes of the gifted girls in their classes. However, the American males reported many negative perceptions of the gifted females in their classes. For example, here is a partial list of some of the negative perceptions we received:

"Math and science are a lot of work and girls just don't want to put in the work."

"Girls aren't logical."

"Girls do more with their friends."

"Girls just care about their hair - how they look."

"Girls can't grasp numbers."

"Girls just follow the leader."

"Girls like humanities not science."

"Girls don't seem to have the patience."

"Girls shy away from abstract thinking"

It should be remembered that the Caucasian males that expressed these views were all between the ages of 16 and 18. A question that the research team has asked themselves over and over again is where and when did such negative impressions originate? Are such impressions based upon observations during the high school years or do they go back to earlier experiences in these children's lives?

There were several interesting comparisons among the groups that related to their careers. Both American groups sought more educational degrees than the Asians. The Caucasian males had expectations far ahead of the other three groups. The Asian males rated "having lots of money" as something they considered very important. The group least motivated by money were the American females. They selected careers which payed less but produced higher levels of satisfaction. The Asian males scored the lowest in this area. All the groups felt that they expected to be the sole support for a family, but the American females had the lowest scores. Many American females thought that they would share support with their husbands. (A smaller number of Asian females also took this position.)

The final set of comparisons dealt with the students' families. Both groups of males had parents with higher levels of education. The parents of the Caucasian males had the highest educational levels and the parents of the Asian females had the lowest levels. This is an important variable to consider because a parent's educational background can serve as a resource for the children. The American males seemed to be able to use this resource when conducting their research and also in planning for their future careers.

These career expectations were an important focus for our interviews. We tried to discover if the parents of these gifted children had different expectations on the basis of gender. Did the parents have the same expectations for their daughters and sons? For the Caucasians we found that the parents stressed productive technical careers for the males but not for the females. Many of the Caucasians

said that for females, "being happy and well-adjusted" was the primary goal. None of the gifted Caucasians had sisters in the advanced science and math classes. In many cases the boys said that their sisters were not interested in the technical areas. For the Asians, we found that the parents' expectations were the same for both boys and girls.

Several of the Caucasians also reported that American parents were much more protective of their daughters than their sons. This meant that many girls were discouraged from attending the different university summer programs or from working in different research labs away from home. The Asian parents also seemed to worry about their females' participation in these research activities, but in most cases they did not prevent their participation.

The Asian families placed such a high premium on education that the females were encouraged to explore any talent that they had. The Asian students reported to us that education ranked first in their homes, "way ahead of money." These parents emphasized education as the foundation of one's career - "Everything is built upon it." It is for these reasons that the Asian females also felt that the family network would help them balance a career and a family. Many of the American females foresaw difficulty in this area.

Conclusions

1. The Asian experience in America, particularly for these new immigrants, has produced some interesting contrasts with the indigenous Caucasian students. The Asians put much more time

into their studies. Their families have very high expectations for their success in school and for their future economic achievement. The family generates a very supportive atmosphere for making strong commitments to excellence. These Asian students seem to gravitate to the technical math and science areas where their language deficiencies will not become obstacles.

2. Perhaps the most startling finding of all was that psychological and attitudinal differences between the sexes did not hold for Asian students. Among the Asians, we did not find the same differences that distinguish female students from male students. This finding helps explain the absence of gender difference found among Asian students with regard to success in the Westinghouse Talent Search (Connolly & Primavera, 1983).

3. Earlier in this article we referred to the different reasons that researchers have given to explain the sparsity of female scientists, engineers and mathematicians. How does our data fit into these competing conceptions? We have found that equal numbers of Asian females select the advanced science and math courses and do equally well in the national contests. We would predict that these females will also do well on the SAT-M. It has been shown that Asian females in at least one study (Sells, 1980) do select science college majors in much higher numbers than Caucasian females. Occupational data also show that more Asian females become scientists, engineers and mathematicians than their Caucasian counterparts (NSF, 1974). The technical orientation that we found among the Asian females could be interpreted as a case of over-compensa-

tion. The innate ability group could argue that Asian females do have less ability than males, but they just work harder to overcome these liabilities. The other interpretation is that socialization differences, particularly those that originate within the Asian family, account for the increased achievement and interest in science and math by this sample of Asian females. In our view, we feel that the data from this study support the "differential coursework hypothesis." Furthermore, we feel that the socialization patterns seem to originate within each child's family long before they get to high school. We would urge researchers to conduct studies with much younger groups of gifted females to try and isolate where and when the different socialization patterns begin.

Postscript

Many educators who know about the "differential coursework hypothesis" have assumed that the real problem lies with not counseling more females to take the advanced science and math courses. Our study shows that even Caucasian females that take these courses are still very different from the males in these classes. We believe that Caucasian females will not select technical careers in any great numbers until these differences are reduced.

TABLE 1

Significant Variables in Terms of Ethnicity

Variable	Description	F	Level of Significance
1	Importance of friends in making decision to enter advanced math and science courses	2.732	.0441
2	Desire to win Westinghouse Award/Scholarship	6.269	.0004
3	Desire to win honors, prestige, scholarships	3.614	.0137
4	Technical reading	2.715	.0451
5	Semantic Differential - Conservative/Radical	2.3	.050
6	Time spent in religious activities	8.511	.00001

TABLE 2

Significant Variables in Terms of Ethnicity and Gender

Variable	Description	F	Level of Significance
7	Father's education	6.850	.0002
8	Mother's education	4.596	.0037
9	Importance of sports	3.614	.0137
10	Time spent participating in sports	7.650	.0001
11	Time spent in outdoor activities	3.264	.0218
12	Importance of doing research	4.549	.0039
13	Importance of socializing	6.797	.0002
14	Time spent socializing	4.556	.0039
15	Sensitivity to resentment caused by high achievement	4.360	.0051
16	Degrees sought	4.323	.0053
17	Expectation to support family	9.237	.00001
18	Satisfaction vs. salary	7.013	.00001
19	Positive attitude toward myself	3.252	.0222
20	Importance of having lots of money	8.297	.00001

Note 1

Benbow and Stanley have produced convincing data that large sex differences do occur among the highly precocious seventh and eighth graders who have entered the many contests sponsored by the Study of Mathematically Precocious Youth (SMPY). These authors have been careful to state that their findings are limited to just the top 2% of students and may not apply to sex differences in the general population.

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